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Facility Modernization Report

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Disclaimer

This work was performed under the auspices of the U.S. Department of Energy by University of California, Lawrence Livermore National Laboratory under Contract W-7405-Eng-48.

Facility Modernization Pilot Study

Lawrence Livermore National Laboratory

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DISCLAIMER

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Modern and technologically up-to-date facilities and systems infrastructure are necessary to accommodate today's research environment. In response, Lawrence Livermore National Laboratory (LLNL) has a continuing commitment to develop and apply effective management models and processes to maintain, modernize, and upgrade its facilities to meet the science and technology mission. The *Facility Modernization Pilot Study* identifies major subsystems of facilities that are either technically or functionally obsolete, lack adequate capacity and/or capability, or need to be modernized or upgraded to sustain current operations and program mission. This study highlights areas that need improvement, system interdependencies, and how these systems/subsystems operate and function as a total productive unit. Although buildings are "grandfathered" in and are not required to meet current codes unless there are major upgrades, this study also evaluates compliance with "current" building, electrical, and other codes. This study also provides an evaluation of the condition and overall general appearance of the structure.

Using a cross-section of eight facilities selected from the FY02 Facility Assessment and Ranking System (FAaRs), this study assesses the technical obsolescence and major subsystems infrastructure to better understand how aging facilities (see Table 1) and the changing research environment are impacting the Laboratory. Appendix A provides a detailed evaluation of each of the eight facilities.

Table 1. Facilities selected based on age, type of facility, and condition.

Facility	Name	Age	Technology Status *	Summary Condition
113	Computation/LCC Facility	38	Satisfactory	Fair
141	Electronic Shops	50	Marginal	Good
241	Materials Science Facility	44	Satisfactory	Fair
253	Hazards Control Facility	45	Unsatisfactory	Fair
271	Protective Forces Facility	31	Satisfactory	Fair
361	Biology/Bio Tech Facility	35	Satisfactory	Fair
381	National Ignition Facility	29	Satisfactory	Fair
851A	Hydro Firing Facility	44	Satisfactory	Adequate

*Note: Ranking scale: (1) fully current, (2) satisfactory, (3) marginal, (4) unsatisfactory.

Figure 1 illustrates the percentage of buildings at LLNL that are more than 40 years old—totaling 33% at the Livermore Main Site and over 50% at Site 300. As facilities continue to age, this trend and the number of facilities exceeding 40 years will increase each year. The technical status of facilities are affected by their age, the changing research environment, and several other drivers including the following:

- Multiple higher-powered desk top computers are now integral components of every office.
- Experimental work is requiring increasingly higher thermal and mechanical stability and precision, frequently in a clean environment.
- Research and computing environments are requiring reliable, high-quality, low-voltage electrical distribution.
- New electronic controls (e.g., variable frequency drives) installed without line filters can degrade power quality.
- Routine communications are requiring higher performance networks and system support.
- Building, electrical, architectural, mechanical, fire, and other codes have changed significantly since completion of original construction.
- Major facility subsystems (electrical, mechanical, controls, alarms, etc) are aging, some are technologically obsolete, and replacement parts are difficult to obtain or are no longer available for some equipment.

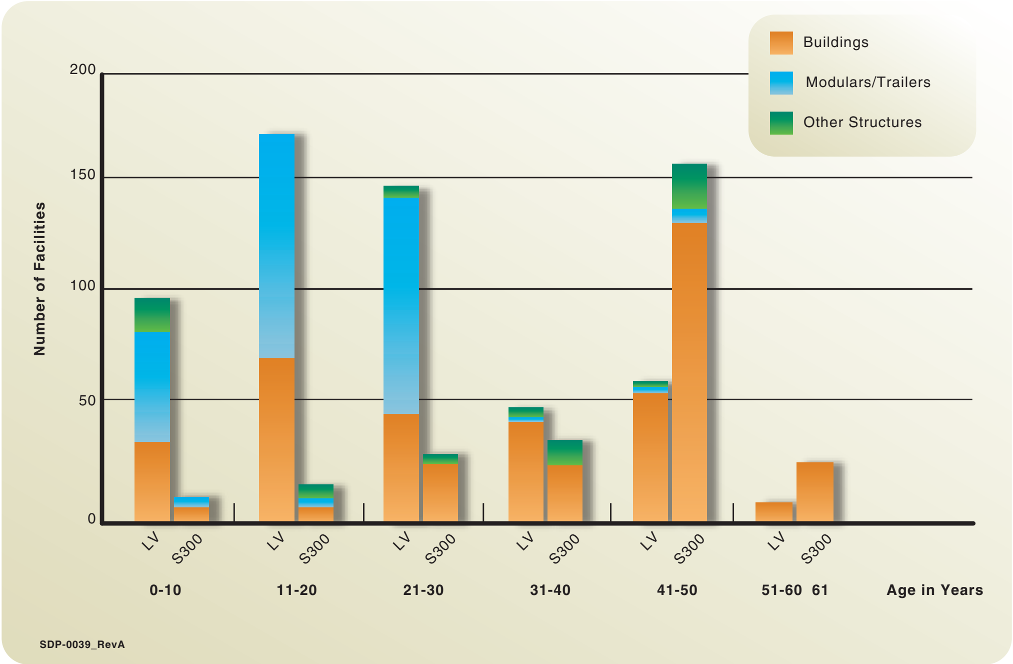

Figure 1. Distribution of facilities by age at LLNL.

For the purpose of this study, *modernization* is defined as providing new capacity; new capability; changes in standards, regulations, and technology; or a major upgrade of a building or subsystem to meet the current and changing mission needs of a program. *Maintenance* is defined as replacing building systems and equipment "in kind" to maintain the systems and equipment in acceptable condition for current use and to achieve the expected building life.

Funding of replacement-in-kind equipment components and major system upgrades also need to be considered as the funds are provided from two different sources. Replacement of components and systems in-kind is accomplished using maintenance reinvestment operating funds. The National Nuclear Security Administration (NNSA) Facility and Infrastructure Recapitalization Program (FIRP) initiative is also being used to replace worn out components and to reduce the backlog of maintenance. Modernization and replacement of entire subsystems or capacity increases require capital funding and cannot be accomplished with operating funds.

Appendix A provides a summary of opportunities and cost estimates for modernizing; upgrading building systems; updating current building, electrical, and other codes; installing energy efficiency improvements; and improving the image of facilities. Separate Laboratory studies and reviews are currently in progress to evaluate emergency generator replacements, communication network upgrades, alarm system cost options, energy, American Disability Act (ADA) and seismic upgrades.

The Laboratory and the Department of Energy (DOE) are committed to re-investing in facilities and infrastructure to support program activities, mission, research, and technical capabilities. During the 1990s, the DOE established that the Facilities and Infrastructure (F&I) of the DOE Weapons Complex were aging and not well maintained. The F&I condition was declining due to a lack of investment. In FY01, the NNSA presented an F&I Assessment Plan to the House Energy and Water Development Committee to halt and correct the deterioration within the complex.

In response to the declining F&I condition, corporate goals were set by NNSA in FY02 to stabilize deferred maintenance by the end of FY05 and return programmatic facilities and specific other important infrastructure to an assessment level of “good to excellent” by the end of FY09. Institutional facility management and budget processes were also included as part of the goals to maintain facilities and infrastructure equal to or better than industry standards. To achieve these goals, the NNSA’s FIRP was funded as a corporate initiative to make significant improvements in F&I that enable NNSA and the Laboratory to better meet their national security missions.

Pilot F&I projects resulted in significant enhancements in the Laboratory’s facility management processes and funding of high-priority, mission-critical maintenance projects. Work processes, systems, condition assessments, good management practices, and a maintenance prioritization process that work well at the Laboratory were institutionalized to accomplish NNSA’s goals.

As part of this process, both the DOE and the Laboratory recognize that aging facilities and their major subsystems need to be modernized to meet the changing mission needs of the program. One of the F&I challenges stated in the Laboratory’s annual *Ten Year Comprehensive Site Plan (TYCSP)* is to arrest technical obsolescence. In response, the *Facility Modernization Pilot Study* addresses technical obsolescence to formalize building-specific modernization plans to develop a strategy, methodology, and process to identify potential modernization opportunities; major upgrades of aging facilities; building, electrical, architectural, fire, and other code improvements; and the estimated costs.

This study used FAaRS to select a cross-section of eight buildings based on age, type of facility (e.g., office/laboratory, computations, Livermore Computing Center, shop/office), condition, and technology status (as shown in Table 1). The buildings were reviewed based on the requirements of their current use (potential changes in building use were not considered). Technology status, obtained from the LLNL Facility Information Tracking System (FITS), is based on the Facility Manager's evaluation of a building and its major subsystems to meet current operations and program mission. The Summary Condition is the Facility Condition Index (FCI) derived from the ratio of the Backlog of Maintenance to Replacement Plant Value (RPV). The facilities and building systems were evaluated for their current use by a multi-disciplined team of engineers, maintenance specialists, and estimators (i.e., electrical, mechanical, and architectural). Walkthroughs were performed to obtain a general overview of each facility and its major subsystems (facility team members included: an Associate Director Facility Manager [ADFM] representative, Facility Point of Contact [FPOC], and/or Building Coordinator). Estimators developed "D" Level cost estimates (+/–50%), assuming FIRP funding using a very brief description of needs. No formal drawings or specifications were developed by engineering staff.

As documented in Appendix A, the assessment of each building and major subsystem determined if there were capacity or capability deficiencies; if improvements were needed to meet current building, electrical, architectural, fire and other codes, and/or ADA compliance requirements common to the buildings used in this study. Other assessment techniques and processes included the following:

- Assessing buildings as a total productive unit—functions, performance of major subsystems, and their inter-relationships, including their overall structure and interior condition (i.e., image).
- Creating a list of main circuit breaker(s), loads (amperes), and demand (kilowatts/hour) for each facility (see Figure 2).
- Comparing one-line electrical diagrams and panel schedules with actual field installations.
- Addressing potential safety issues.
- Assessing potential energy efficiency improvements.
- Providing engineering assessments and cost estimates to the ADFM and Plant Engineering Maintenance/Operations(M/O) for information, future planning, and potential replacement in-kind and modernization projects (capital).
- Identifying code improvements needed to bring facilities up to current code.
- Updating the Laboratory's Condition Assessment Survey (CAS) reporting system with system and code improvements identified in this study.

General Findings, Conclusions, and Recommendations

Finding—Facilities, their major subsystems, function, operation, performance, safety and reliability, and how they are integrated need to be viewed as a total productive unit.

Discussion of Findings. Currently, the focus of maintenance and facilities investment is on "replacing-in-kind" components or a subsystem rather than an upgrade or modernization of an entire electrical or mechanical distribution system. Furthermore, the focus of maintenance is on individual replacement of major subsystems and components rather than on the interdependencies of the systems and their function as a total productive unit. Replacement-in-kind of worn out, obsolete, and inefficient facility components has helped to modernize facilities, but the program has not focused on upgrades or modernization of entire subsystems. The updated technology built into new replacement-in-kind equipment has resulted in improvements in operation, control, efficiency, reliability, and precision. However, a broader, coordinated, interactive systems approach to facility planning is needed to evaluate entire systems, systems integration, the replacement of components of these systems, and the actual programmatic requirements.

- ***Conclusion.*** Preventive maintenance, repair, and replacement-in-kind tend to focus on individual subsystem categories (e.g., mechanical, electrical, alarms) or major components of a system. These subsystems are interdependent and must work in concert with each other as a total productive unit to meet a program's mission requirements. If one system's capacity, capability, or reliability is not performing to expectations or current program need, it may affect the total productivity of the facility.

- ***Recommendation.*** Emphasis needs to be placed on the interdependencies of major subsystems, their function, operation, performance, and replacement as a total productive unit to meet current program mission and requirements.

Finding—The total cost profile (total needs) of a facility (deferred maintenance, code improvements, modernization improvements, architectural, seismic, communication networks, etc.) needs to be evaluated considering future mission, operation, and investment.

Discussion of Findings. Facility needs for deferred maintenance, modernization, capacity increases, seismic upgrades, code improvements, architectural improvements, and communication networks and their costs are generally viewed independently. Facility plans integrating the total needs, costs of needs and requirements, and total cost profile for buildings have not been developed.

- ***Conclusion.*** The estimated costs of each of these major components needs to be combined into a facility plan with a total cost profile for each building (i.e., its total needs).

- ***Recommendation.*** Each facility should have a Facility Plan, updated periodically, which includes its total needs, individual costs, total cost profile, and tentative schedule for accomplishment. A facility's total cost profile (deferred maintenance, code updates, modernization investment, capacity upgrades, seismic upgrades, and general appearance) needs to be balanced against its life expectancy, investment to date, future mission, cost to demolish, or estimated cost to construct a new facility.

Finding—Many of the building infrastructure components are original, some are badly deteriorated, beyond their life expectancy, and are technically obsolete.

Discussion of Findings. Field inspections and Condition Assessment Surveys (CAS) of deferred maintenance for each of the facilities selected indicate that several equipment components are in "poor" to "fair" condition or beyond their design life.

Many of the aging and outdated facilities have some of the original electrical and mechanical systems and components installed at the time of construction. Field inspections noted that some of the system components have been abandoned in place, others have exceeded their design life; and electrical cables have deteriorated and some have cracked insulation. In some cases, vendors no longer provide support for mechanical or electrical equipment and repair parts are difficult to obtain or are no longer available. Some facilities have pneumatic control systems that are technically obsolete, costly to maintain, and sometimes difficult to troubleshoot.

- ***Conclusion.*** The FIRP and internal maintenance reinvestment activities are addressing these issues and are making progress towards correcting deficiencies. The Laboratory's maintenance reinvestment program has been recognized by the Government Accounting Office and NNSA and has become a model for other DOE organizations.

- ***Recommendation.*** Continue with a strong internal reinvestment program and FIRP and continue making progress towards correcting deficiencies.

Finding—Safety, operation, and reliability of systems could be improved by updating to current electrical and building codes.

Discussion of Findings. Significant changes in building, electrical, architectural, fire, and other codes have been made since many of the Laboratory's buildings were originally constructed. Existing systems and structures met as-built codes and are grandfathered in until major upgrades or alterations are made. The new codes implement changes that can improve the safety, operation, reliability of systems, and integrity of the structure. For example, updating to current electrical codes would require replacement of existing undersized low-voltage neutral and ground cables. Electrical codes in existence when the facilities were constructed allowed neutral and ground cables to be sized at 50% of the supply cable rating. Current code requires neutral and ground cables to be sized at 100% of the supply cable rating.

- ***Conclusion.*** Electrical distribution components such as transformers, main circuit breakers, and panels would benefit by updating to the current code and would improve the operation and increase the reliability. Updating to current codes also would meet current building codes for mechanical systems, building, and ADA requirements.

- ***Recommendation.*** Consider implementing an integrated program to update mechanical, electrical, architectural, and alarms to current codes. As components are replaced through the internal maintenance reinvestment program and FIRP, continue to implement current code improvements.

Low-Voltage Electrical Distribution Systems

Finding—Many of the electrical components are original, some are deteriorated and beyond their expected design life.

Discussion of Findings. System components (transformers, panels, circuit breakers, and electrical cables/feeders) are aging; some are beyond their expected design life and range from poor to fair condition. Replacement parts are no longer available for some of the older panels. Electrical feeder insulation in some cases is severely deteriorated and exhibits damaged insulation.

Finding—Electrical main circuit breaker capacity serving facilities is adequate.

Discussion of Findings. Measurements of usage (kw/h) and amperage were taken at each of the facilities to determine average and peak operating loads. Refer to Figure 2 for a summary of the main circuit breaker(s) operating loads, expressed as 80% of nameplate capacity for each facility. Only one of the loads (B113, TB840) exceeded the breaker's desired (internal LLNL standard) operating capacity. No loads exceeded the main breakers nameplate capacity. The load at B113 will be significantly reduced as computational capability is shifted to the newly constructed Terascale Simulation Facility (TSF).

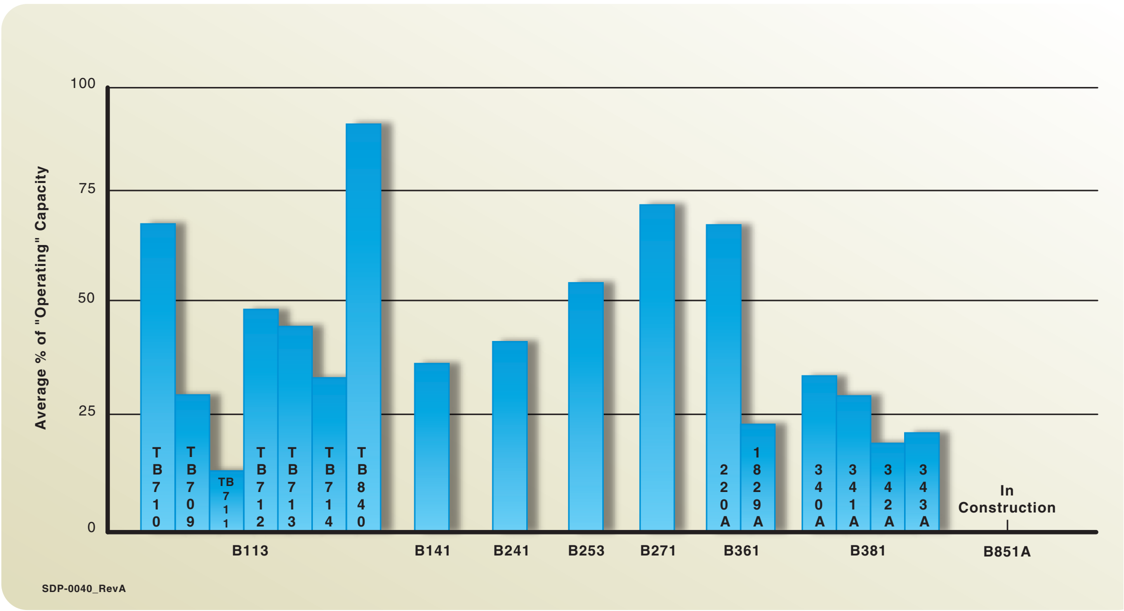

Figure 2. Low-voltage electrical system main circuit breaker operating loads at 80% of nameplate capacity.

A field inspection of the main breakers at each facility was made to determine whether or not multiple trip setting breakers were installed. Some breakers were old style thermal trip type with only a minimum/maximum trip setting. Without proper coordination between upstream and downstream circuit breakers, there is an increased risk of nuisance tripping which could result in potential outages and damage to experiments and/or facility equipment. Circuit breakers with multiple trip settings provide better coordination of a facility's low voltage electrical distribution system.

- ***Conclusion.*** The capacity of the main circuit breakers was found to be adequate. Replacement of the old style main breakers with multiple trip setting units would provide more flexibility and improved coordination of low voltage electrical distribution systems.

- ***Recommendation.*** Replacement of minimum/maximum setting breakers with multiple trip setting breakers, when properly configured, would improve reliability, operation, and breaker coordination.

Finding—Installing ground fault protection at main breakers rated at less than 1,000 amps could prevent a facility outage.

Discussion of Findings. The National Electrical Code (NEC) does not require ground fault protection for main breakers or service disconnects rated at less than 1,000 amps. As a result of this condition, a ground fault of a lighting ballast, motor or feeder cable can trip the main circuit breaker resulting in the shutdown of a facility.

- ***Conclusion.*** Although the electrical code does not require ground fault protection for main breakers rated at less than 1,000 amps, this may not be adequate for certain LLNL operations. The incremental cost of ground fault protection of a facility's operation would more than offset the loss of an experiment, data, or manpower costs.

- ***Recommendation.*** To provide improved operation and reliability, all installed main and feeder circuit breakers in switchboards should be provided with ground fault protection tailored to the operations of the facility.

Finding—There have been significant changes in the NEC since the buildings were originally constructed.

Discussion of Findings. Each of the facilities assessed had at least one low-voltage electrical distribution feeder, breaker, panel, or transformer that needs to be updated to meet current code. Although the facilities meet as-built electrical codes, assessment of the facilities to meet current codes resulted in the following:

- Circuit breakers and electrical feeders were "T" tapped exceeding 25 feet from the tap.
- Electrical panels need secondary protection to isolate panels when being worked.
- Panel circuit breakers were not properly coordinated—downstream breaker exceeds capacity of upstream breaker.
- In some installations, panels and circuit breakers do not have adequate interrupting capacity ratings (available fault current exceeds the rating). Unless a circuit breaker successfully interrupts the fault, the resulting excess amperage can rapidly heat components to very high temperatures that can destroy insulation, melt metal, and start fires.
- Panels had inadequate working clearance (minimum 36 inches required).
- Multiple taps were found on some transformers serving panels, which could potentially overload the transformer.
- Neutral and/or ground wires are undersized at 50% of current capacity (Desktop computers and motors can create power quality and harmonic issues where undersized wiring is installed). Current code requires neutral/ground wires to be sized at 100% of circuit capacity—neutral/ground wires sized at 200% of circuit capacity are recommended where desktop computers are used.
- Several buildings had electrical feeder runs which contain old style (RHW) insulation (lower operating temperature) which should be replaced with THHN/THWN (LLNL Standard) type feeders.
- Electrical one-line diagrams and panel schedules were not consistent or were missing entries.

Although there has been an occasional electrical outage of a building, no known major damage or fire has occurred as a result of a "low voltage system" component failure or ground fault. As a result, low voltage electrical distribution systems are generally ranked low in probability of failure.

- ***Conclusion.*** Operation, safety and reliability of low-voltage electrical distribution systems could be improved by replacing aged and deteriorated components, performing load and breaker coordination studies, and updating to current code and technology. Low voltage electrical distribution systems currently are ranked low in probability of failure and ranking priority.

- ***Recommendation.*** Consider implementing an integrated program to perform load and breaker coordination studies and replacement of low voltage systems and their components to improve operation, reliability, and conformance to current code. Update panel schedules, as required, to show current configuration of electrical system.

As part of this process, the maintenance priority, ranking, and funding of low voltage electrical systems should be re-evaluated.

Mechanical Systems

Finding—HVAC capacity in some facilities was either marginal or could benefit from centralization. Operation, reliability, maintenance, and energy efficiency could be improved by installation of direct digital controls (DDCs) and front-end computers.

Discussion of Findings. Existing air handling and cooling systems are inadequate or marginally meet the needs of five facilities. Central air cooling capacity (B141, B253, B271 and B361) is being augmented by small standalone air conditioning units and or heat pumps. Existing cooling and airflow capacity is inadequate to serve both the high and low bays in B241. Pneumatic control systems, standalone DDC panels or combinations of both for monitoring the HVAC systems are installed in several of the buildings. Constant volume reheat systems are used in some office areas and laboratories.

- ***Conclusion.*** Replacement of these systems and or components with central air handling and cooling systems, variable air volume boxes (VAV boxes), where applicable, variable frequency drives, direct digital controls, and front-end computers to monitor performance would improve operation, reliability, maintenance, and energy efficiency.

  Chiller replacement and centralization of systems are also impacted by funding requirements. Chillers are replaced "in-kind" with operating funds when installing a unit(s) of larger capacity and centralization of the system would improve a deficient system, but this would require capital funding that is not available.

- ***Recommendation.*** An integrated program and plan to modernize, upgrade, or increase the capacity of marginal air handling and cooling systems needs to be developed and implemented. This program should include interconnecting existing standalone DDC panels to a host computer to monitor the HVAC and installation of VAV boxes and variable frequency drives to improve operation, maintenance, and energy efficiency.

Discussion of Findings. Heating capacity was generally found to be adequate except for one facility (B381) where an existing boiler was tapped to heat an adjacent building. In the winter months, the single boiler cannot meet the demand for both buildings. The east side (office area) of B141 is served by a boiler operating at about 75% capacity which is adequate for operations. Space heating for the east side laboratory is provided by old, inefficient gas fired unit heaters. Building 141 lacks a boiler to heat the west side of the building. Old, inefficient, gas fired unit heaters are used to heat the west side. In B253 there are three boilers and three chillers located in three mechanical rooms serving the west, middle, and east wings of the facility. The three boilers could be consolidated and the system centralized to handle the heating requirement for the entire building which would improve operation and energy efficiency. Consolidation also would provide separate mechanical rooms for the boilers and chillers.

- ***Conclusion.*** Heating capacity is generally adequate except for B381. Old, gas fired unit heaters in B141 should be replaced.

- ***Recommendation.*** A plan to improve inadequate or marginal heating capacity, centralization of the HVAC systems, and installation of DDC in the facilities needs to be developed.

Finding—Uniform building code now requires boilers and chillers to be in separate mechanical rooms.

Discussion of Findings. Chillers and boilers are collocated in the same mechanical room in three facilities (B253, B271, B361). Current code requires refrigeration machinery rooms to be separated from other portions of a building where there is a combustion source. Combustion air or return air cannot be taken from or through a refrigeration machinery room. Open flames, for example a boiler, are prohibited in refrigeration machinery rooms except where a combustion system is interlocked with a refrigerant detection system to shut down the boiler in the event of a refrigerant leak.

- ***Conclusion.*** Refrigeration leak detection systems are not currently installed at the three facilities. Existing systems are grandfathered. However, if modifications are made to the existing nonconforming installation, they will be considered compliant under the new code.

- ***Recommendation.*** Consider providing separate mechanical rooms for boilers and chillers, where practical. Where separate mechanical rooms are impractical, install systems where the combustion system (boiler) is interlocked with a refrigerant leak detection system to shut down the boiler in the event of a refrigerant leak.

Finding—Multiple types and manufacturers of HVAC controls have been installed using different technologies, frequently are not backwards compatible, and are costly to maintain.

Discussion of Findings. The facilities assessed utilize either pneumatic controls or non-networked standalone DDCs or a combination of the two to manage their HVAC systems. Pneumatic or distributed electronic systems are becoming technically obsolete. Pneumatic systems are more costly to troubleshoot and maintain. Maintenance personnel with the necessary knowledge and skills to maintain pneumatic systems are becoming more difficult to find.

DDC systems consist of microprocessor-based controllers with the control logic performed by software. There are direct benefits of DDC over previous technologies (pneumatic or distributed electronic), it improves the control effectiveness, improves operation efficiency, and increases energy efficiency. Electronic sensors for measuring common HVAC parameters of temperature, humidity, and pressure are more accurate than their pneumatic predecessors. Alarms can be routed to various locations on a given network and the trending capabilities allow a diagnostic technician or engineer to troubleshoot system and control problems. Data can also be stored in various formats and run times of equipment can be monitored over time. Energy efficiency strategies such as demand, limited, and load scheduling can be more easily implemented with DDC systems. This can be applied at the zone level by setting different demand levels if desired.

DDC systems at the Laboratory have been supplied by multiple manufacturers. Proprietary software and hardware varies between DDC manufacturers and is not always compatible with alarms as systems are changed or replaced.

- ***Conclusion.*** Pneumatic control systems should be phased out and replaced with DDC systems. DDC systems at the Laboratory need to be standardized using open protocols and web-based interfaces. A standard set of HVAC controls and sequence of operations needs to be developed for various applications (offices, laboratories, shops, etc). Maintenance/Operations is evaluating DDC systems supplied by several manufacturers and is in the process of developing a Controls Master Plan.

- ***Recommendation.*** Phase out pneumatic controls systems and replace with DDC systems. Consider and document the need to update HVAC control systems in the development of the Controls Master Plan.

Finding—Hood and exhaust systems may benefit from centralization of systems.

Discussion of Findings. Three facilities (B241, B253, B361) have multiple, individual hood and exhaust systems and short stacks that penetrate the roof. Some hoods are quite old and should be replaced.

- ***Conclusion.*** Hood and exhaust systems in the three facilities may benefit from centralization of the system. Centralizing the exhaust systems and hoods through a manifold to a single tall stack may eliminate multiple short stacks and their roof penetrations. It would also help to minimize exhaust air from re-entering a facility through outside air intakes.

- ***Recommendation.*** Each of the facilities should perform a cost/benefit study to determine if installing a centralized hood and exhaust system is appropriate considering age and future use of the facility.

Alarm Systems

Finding—Emergency paging and fire alarm systems in some facilities need to be replaced to meet current codes.

Discussion of Findings. Federal Regulations and DOE orders require the Laboratory to install and maintain an operable employee alarm system. The emergency paging and fire alarm systems at the Laboratory have evolved over multiple years and are grandfathered in and are not required to meet current codes unless a facility undergoes major alterations or repairs.

Several facilities (B241, B253, B361, B381) have LLNL designed Emergency Paging (EP) systems that utilize 40-year-old designs and configurations. These designs and configurations do not meet current National Fire Protection Association (NFPA) codes for systems intended for fire service/use. EP systems consist of an amplifier and speakers and have no provisions to accommodate strobe lights that are required to evacuate the hearing impaired.

A second generation paging system called the Emergency Voice/Alarm Communication (EVA) system is installed in some facilities (B113, B141, B271) to distribute voice instructions to employees as well as alert and evacuation signals for a fire emergency. Commonly referred to as the "Red Racks," the EVA has two parts: the Head End located in B313 that provides input and coordination for "live" and pre-recorded voice messages that are distributed to the EVA building systems. The EVA system is recognized (listed) by UL for fire service and meets NFPA code. All EVA systems at the Laboratory are equipped with strobes. EVA technology is about 15 years old; therefore, as the units age repairs become more frequent. Replacement parts are becoming more difficult to obtain because the manufacturer, Faraday, no longer supports the EVA.

System 3 fire alarm systems (30 year old technology) are installed in some facilities (B241, B271, B361). They are UL listed and NFPA compliant. A System 3 fire alarm panel employs conventional zone technology. Alarms cover a zone only (not individual devices). Devices report to the panel as a single alarm for the zone which requires firemen to first go to the panel, locate the zone in alarm, and then search that area for the alarm event.

- ***Conclusion.*** Alarm technology is continually evolving and improving. Fire alarm systems are grandfathered in and are required to meet current codes unless major upgrades are being made to a facility. Some of the existing alarm designs and configurations do not meet current NFPA codes for systems intended for fire service. Repairs to aging systems are becoming more frequent, and parts are becoming difficult to obtain because the manufacturer no longer supports the EVA.

- ***Recommendation.*** The Laboratory Fire Department is evaluating options and the estimated costs to replace EP, EVA, and System 3 Fire Alarm Systems with either a MXLV system, a MXL with a voice communications box, or other approved system (depending on the application and size of the facility).

Architectual Assessment

Finding—Existing guardrails, handrails, stair treads, and door hardware do not conform to current building codes.

Discussion of Findings. The architectural assessment of facilities resulted in the following:

- B141 does not have guardrails installed on the concrete landing on the north side.
- Existing guardrails in B271 and the west side basement access of B361 need to be replaced to conform to current code.
- Existing handrails and ramps need to be replaced at the B141 loading dock to meet current code. The B253 concrete ramp is too steep and needs to be replaced to comply with code.
- Existing open stair treads and risers need to be replaced (B113, B271, B381) to conform to current code.
- Rest rooms in four facilities (B141, B241, B253, B361, B851A) need additional water closets, lavatories, and showers based on occupant load and gender. The rest room (Room 108) in B141 (west side) is a gender-shared rest room. Plant Engineering has existing drawings and specifications for remodeling and improving the rest room facilities in B851A at Site 300.
- Six facilities (B141, B241, B271, B361, B381, B851A) need to provide or remodel rest rooms for handicap access.
- Concrete or steel walled office areas (B141, B241, B253) need to be insulated to R19 including dual pane windows to conform to California Energy Calculations for efficiency.
- Lock sets need to be replaced in buildings to meet current code.
- External appearance of two facilities (B141 and B241) could be improved by constructing new front entrances.

- ***Conclusion.*** Buildings are grandfathered in and are not required to meet current building codes unless major upgrades are being performed.

- ***Recommendation.*** Consider installing any code improvements that may increase the safety of personnel and improved access for the handicapped. Perform energy studies to determine the payback of conforming to California Energy Calculations for energy efficiency (B141, B241, B253).

As existing buildings continue to age, this trend and the number of aging facilities increases at LLNL. As facilities age, their research environment; programmatic missions; and building, electrical, mechanical, and fire codes also change significantly from the time they were originally construction.

To meet current and emerging program needs and requirements, some of the Laboratory's outdated equipment and major subsystems need to be replaced. Some facilities have inadequate or marginal heating and cooling systems and should be modernized and updated to current code. Cooling systems, in some cases, are being supplemented by numerous small AC units. Replacing the individual units with a central plant and distribution system would be more efficient, provide improved temperature control, and reduce maintenance costs. Installing direct digital controls would provide more energy efficient and precise control of heating and cooling systems.

Low voltage electrical distribution systems and components are old (beyond design life), some breakers are not properly coordinated, ground fault protection, in some cases, is inadequate, and some electrical systems need to be updated to current electrical code. Although aging low voltage electrical distribution systems have a low probability of failure, they should be replaced in their entirety to maintain their performance and function with increased reliability.

As the Laboratory continues to invest in its facilities and major subsystems, this process needs to include the function, performance, safety, operation, reliability of the major subsystems, and how they are integrated as a total productive unit. This process begins with understanding the program's mission and needs, then integrating these requirements with a Facility Plan. The Facility Plan should address program requirements, deferred maintenance, replacement of aged or obsolete major subsystems and components, major upgrades, funding strategies, seismic issues, and cost estimates and scheduling. This integrated approach will result in a total cost profile for a facility that can be evaluated and balanced against continued investment, demolition, or construction of a new facility.

Building Evaluations

Building 113 Evaluation

Low Voltage Electrical Distribution Systems (EDS)									
	As-Built Capacity Nameplate	(AMPS) Operating	Adequate Capacity	% Avg. Operating Load	% Peak Operating Load	Condition/ Reliability	Modernization/ Code Improvements	Recommendations	Est. Cost
Major Components									
Main Breakers									
TB709	1600	1280	YES	64	66	Good	Main breakers have	Perform load & breaker	$5000; Note-Operating Funds
TB710	1600	1280		27	31		adjustable trip settings including ground fault protection.	coordination studies	
TB711	1200	960		14	73				
TB712	1000	800		48	89				
TB713	800	640		46	66				
TB714	1000	800		32	34				
TB840	1200	960		89	89				
Distribution Panels						Fair	Four sets of panels E709A5, 710A, 731A, & 714A, plus "B" panels are being supplied with a single breaker. Panels cannot be de-energized without causing outages to both sets of panels.	Install separate circuit breakers in "B" breaker panels	$481,300
Transformers						Fair	Transformers 715TB, 716TB 7 717TB are multi-tapped. Loads have increased over several years posing a potential overload	Install a second transformer 45Kva above existing units.	
Feeder Cables							Some cable runs have old style RHW insulation	Remove & replace RHW cables with THWN insulated cables	
								Total Estimated Cost - Electrical Systems	**$486,000**
Emergency Generators 113GDE01	100KW	150	YES			23 years old - permit source # 1311	EPA requirements for emissions will likely require replacement of generators	Scheduled for replacement in FY2008	$87,000

Building 113 Evaluation (continued)

Mechanical Systems	As-Built Capacity	Adequate Capacity	Condition/Reliability	Modernization/ Code Improvements	Recommendations	Est. Cost
Major Components						
Cooling						
Chillers- Three 250 Ton units with three 775 gpm pumps.	750 Tons	Yes	Two chillers replaced in 1993. Third was also replaced- date unknown. Old chilled water & hot water pumps were not replaced.	Operational & Energy efficiencies can be achieved by installation of DDC system to operate & monitor HVAC system	Provide a new DDC system to monitor & operate chilled water, heating hot water boilers & steam boiler. Install DDC controls to pumps, chillers, & boilers with interface to building energy management system	$185,800.00
Additional cooling provided to computer floor by LCW-cooled floor mounted units (7 units at 25 tons each)	175 Tons			Chilled & hot water pumps are old and inefficient	Replace 3 chilled water pumps & 2 heating hot water pumps	$225,000.00
Air Handlers-Office area: Two - 24,000 cfm units ACU-13 & ACU-15	48,000 CFM	Yes	Replaced- FY04	Existing double-duct mxing boxes are high-maintenance items. Operational & energy efficiencies can be achieved by installing DDC system for air handlers & conversion of mixing boxes to VAV boxes.	Convert mixing boxes in office wing to variable volume double-duct VAV boxes & install variable frequency drives on ACU-13, ACU-15 & FR-1 in penthouse. Install DDC on ACU-13 & ACU-15.	$975,200
Computer Room 10 units	150,000 CFM	Yes	Replaced in 1997	Operational & energy efficiencies can be achieved by installing DDC controls & a central computer to network penthouse, computer room, childd water & boiler systems.	Install new DDC controls to network penthouse computer room, chilled water & boiler system controls. Provide central computer for monitoring HVAC	$54,300
Heating –						
Two 2000 BTU/H heating hot water boilers with two 265 gpm pumps, one steam boiler	4,000 BTU/H	Yes	Replaced in 2000		Adequate for future use	
Plumbing		Yes	Good			
Fire Sprinklers		Yes	Poor	Fire suppression system is not seismically braced	Provide seismic bracing for fire suppression system	$117,800
Mechanical Utilities		Yes	Good			
Sewer		Yes	Good			
					Total Estimated Cost - Mechanical Systems	**$1,558,200**

Building 113 Evaluation (continued)

Architecture							
	As-Built Capacity		Adequate Capacity	Condition/Reliability	Modernization/ Code Improvements	Recommendations	Est. Cost
Major Components							
Restrooms					NONE	NONE	
Door Hardware					Some existing locksets do not comply with UFAS section 4.1.3.9	Replace locksets	
Stairs					Open tread stairs throughout facility do not meet current code UFAS 4.9.2	Modify stairs to comply with code	
						Total Estimated Cost - Architecture	**$67,200**

Alarm Systems							
	Number of Devices	EVA/EP	Number of Speakers	Condition/Reliability	Code/Tech Improvements	Recommendations	Est. Cost
Fire System Type							
MXL-R	201	EVA	134	EVA technology is 15 years old	EVA systems no longer vendor supported. Parts will eventually become unavailable. Fire Alarms & paging systems are stand-alone.	Install MXL-V fire alarm and paging system	**$73,700**
Communications Network							
						Provide a communications outlet in each office. Each station to contain 3 Cat5E (1 for voice, two for data) & 4 laser enhanced fiber optic connections.	**$267,230**

Building 141 Evaluation

Low Voltage Electrical Distribution Systems (EDS)

	As-Built Capacity Nameplate	(AMPS) Operating	Adequate Capacity	% Avg. Operating Load	% Peak Operating Load	Condition/Reliability	Modernization/ Code Improvements	Recommendations	Est. Cost
Major Components									
Main Breakers	2,000	1,600	Yes	34	36	Fair	Main breaker has min/max trip settings	Install new main circuit breaker with multiple trip settings	$7,700; Note-Operating Funds
Distribution Panels			Yes			In CAS 40/50 yrs. old - Poor to Fair	Breakers improperly coordinated. Panel 890B had no overcurrent protection. This was corrected. Panels 890A & 890B have adjustable trip settings and ground fault protection.	Perform load & breaker coordination study.	$7,500; Note-Operating Funds
Transformers			Yes			In CAS 40 to 50 yrs. old - replacement parts unavailable		Replace with Maintenance Funds	In CAS
Feeder Cables			No			Cracked insulation, badly deteriorated -40 to 50 yrs. old; poor, undersized neutral/ground wires -54 yrs. old	Five runs have old-style insulation. Seven runs have undersized neutral/grounds based on current code	Remove & replace RHW cable & undersized neutrals/grounds with THWN cable	$38,477
								Total Estimated Cost - Electrical Systems	**$53,677**
Emergency Generators	30kw	104	Yes			54 years old. Permit Source # 1313	EPA requirements for emissions will likely require replacement of generator	Scheduled for replacement in FY2007	**$90,000**

Building 141 Evaluation (continued)

Mechanical Systems							
	As-Built Capacity		Adequate Capacity	Condition/Reliability	Modernization/ Code Improvements	Recommendations	Est. Cost
Major Components							
Cooling							
Chillers - East side: Two- 50 ton scroll compressor water cooled units & one - 22,000 cfm water cooled; packaged air conditioning unit (ACS-01)	100 Tons		Yes	Chillers in excellent condition(2 years old) and serve office area. Office area HVAC system is variable air volume with hot water reheat. Supply air temperature is automatically reset by the DDC system.	Installed digital controls are stand alone. Existing chillers do not have DDC controls. East side: Old AC units should be combined into a single unit with VAV terminals & DDC controls.	East Side 1. Interconnect existing stand-alone DDC panels & provide a host computer to monitor HVAC controls. Provide ethernet connection for remote monitoring East Side of B141.	$29,500
Air Handlers - East side consists of two units (one 12,900 cfm & one 19,000 cfm) plus a heat pump of 2000 cfm capacity (ALHPS-03);	64 Tons		Yes	Fair Condition-25 years old. East Side Laboratory is served by a water cooled packaged air conditioning unit. HVAC systems are constant volume. Gas fired heaters are provided for heating.	Existing air handlers & miscellaneous AC units need to be modernized. Centralize into a VAV AC system located on roof.	2. Replace laboratory water-cooled air-conditioning unit (ACS-01& ACS-06)) & heat pump (ACHPS-03) with a variable air volume (VAV) air conditioning system.Provide new VAV terminal. Units with hot water reheat for space temperature control. Locate new air handling unit on roof & install DDC controls. Remove gas fired heaters.	$483,500
				Existing DDC panels are stand alone. Operational efficiencies and improved temperature controls could be achieved by interconnecting the panels and providing a central computer for monitoring the systems.	Install DDC system	3. Provide DDC system to monitor East Side chillers. Connect to central computer	$12,100

Building 141 Evaluation (continued)

Mechanical Systems (continued)

West side: One 96 Ton, air cooled unit.	96 Tons		Yes	Good	Not applicable	None	
West side has four units (ACU-03.04, 86 tons-05,06) ranging from 8,500 cfm to 10,700 ctm serving lab space, total air handling capacity is 38,400 cfm small packaged AC units & heat pumps provide heating & cooling to a portion of West side.	86 Tons		Yes	Poor to Fair - exceeded design life, 25-30 years old	Centralize and modernize air handlers & packaged units to achieve operational and energy efficiency	West Side 1. Replace existing four air handlers & miscellaneous small packaged air conditioning units & heat pumps with a VAV air conditioning system using chilled water & heating water. Install VAV terminals with hot water, reheat for space temperature control. Locate new unit on roof, install DDC controls & connect to host computer. Demolish gas-fired heaters.	$914,000
						2. Install DDC controls & sensors to monitor existing chillers.	$12,100
Heating							
East side boiler	903,000 BTU/H		Yes	Excellent- 3 years old			
West side boiler	None exists		No	Old, gas-fired unit heaters	No boiler exists on West Side	Install a water heating boiler, pumps and distribution system. Remove gas fired heaters.	$397,500
Plumbing	Satisfactory		Yes	Good	None	None	
Fire Sprinklers	Satisfactory		Yes	Good	None	None	
Mechanical Utilities	Satisfactory		Yes	Good	None	None	
Sewer-West Side	No		No		No sewer connection exists on West side	Install a sewer connection on West side	$51,200
						Total Estimated Cost - Mechanical Systems	**$1,899,900**

Building 141 Evaluation (continued)

Architecture

	As-Built Capacity		Adequate Capacity	Condition/Reliability	Modernization/ Code Improvements	Recommendations	Est. Cost
Major Components							
Restrooms	Existing, fixtures are inadequate		No		Code requires two additional water closets & one lavatory	Modify restrooms & add fixtures	$62,935
Door Locksets & Signage					Door locksets are not to UBC	Replace door locksets and install signage	$35,525
Dock					Guardrails, ramps & stairs do not conform to UBC	Replace existing guardrail ramps and stairs	$89,145
Exterior Concrete Walls					Office area walls are not insulated to current energy standards	Insulate walls w/ rigid R19 insulation or tex-coat exterior (see estimate*)	$874,605
South Main Entrance					South side access needs to be improved for handicapped. Facility is an office/lab but has a warehouse appearance	Contruct handicap access and new store front entrance to make the facility more attractive	$301,490.00
*** Deduct $312,000 for tex-coat on exterior in lieu of insulation**						**Total Estimated Cost - Architecture**	**$1,363,700**

Alarm Systems

	Number of Devices	EVA/EP	Number of Speakers	Condition/Reliability	Code/Tech Improvements	Recommendations	Est. Cost
Fire System Type							
MXL- R	12	EVA	77	EVA system no longer vendor supported	Fire alarm & paging systems are stand alone	Combine fire alarm & paging systems and install MXL-V system	**$42,350**
Communications Network							
					Provide a communication outlet in each office. Each station to consist of 3 Cat5e (1 for voice, 2 for data) and 4 laser enhanced fiber optic connections.		**$326,010**

Building 241 Evaluation

Low Voltage Electrical Distribution Systems (EDS)									
	As-Built Capacity Nameplate	(AMPS) Operating	Adequate Capacity	% Avg. Operating Load	% Peak Operating Load	Condition/ Reliability	Modernization/ Code Improvements	Recommendations	Est. Cost
Major Components									
Main Breakers	3,000	2,400	Yes	41	42	Panel 600A updated in 1998 and has ground fault protection.	Main breaker does not have multiple adjustable trip settings. Breakers in Panel 600A do not have selective trip settings.	Install multiple tripsetting adjustable main breaker & perform load and breaker coordination study.	$20,700
Distribution Panels						Fair - 34 to 44 years old		Perform load & breaker coordination study	5,000
Transformers						Fair - 40 to 50 years old	Five transformers, double tapped	Evaluate loads and eliminate double taps	$184,300
Feeder Cables			No			Poor - 44 years old	Twenty-seven feeder runs have old style insulation. Neutral/ground wires to twelve panels are undersized	Replace/update feeders with new style (THWN) cable. Replace undersized ground/neutral wires	
								Total Estimated Cost - Electrical Systems	**$210,000**
Emergency Generators	150kw	226	Yes			In CAS - 50 years old Permit Source # 1401	EPA requirements for emissions will likely require replacement of generator	Generator scheduled for replacement FY2007	$87,400

Building 241 Evaluation (continued)

Mechanical Systems						
	As-Built Capacity	Adequate Capacity	Condition/Reliability	Modernization/ Code Improvements	Recommendations	Est. Cost
Major Components						
Cooling						
Chillers - Two helical-rotary, water cooled machines, 110 & 125 tons. Two air-wash units serving low & high bays	235 Tons	No - cooling & airflow inadequate to serve both low & high bays	Existing chillers are new. Replaced air wash units serving low & High Bay in FY04 with heating & cooling air handling units	Cooling & airflow capacity is inadequate to serve both low and high-bays	1. Install additional 60-ton central air-conditioning system in High-bay.	$657,100
					2. Replace old pneumatic controls with DDC controls for Laboratory room pressure control & miscellaneous AC units. Provide DDC ethernet connection for remote monitoring of building.	$248,400
					3. Replace office constant volume reheat system with variable air volume reheat system.	$161,700
Air Handlers - Nine units ranging in size form 2700 to 31,000 CFM	Cooling capacity 200 Tons, 101,000 CFM	Yes	30-40 years old. Several units have exceeded their design life or are moderately deteriorated	None	CAS replacement	Operating Funding
Heating						
Boilers - Three 1,700,000 BTU/H	5,100,000 BTU/H	Adequate	Replaced old boilers in FY04. Installed three new 1,700,000 BTU/H boilers	None		
Plumbing	Satisfactory	Yes	Good	None	None	
Fire Sprinklers	Satisfactory	Yes	Good	None	None	
Mechanical Utilities	Satisfactory	Yes	Good	None	None	
Fume Hoods	21	Yes	Fair	Fume hoods are very old & should be replaced	Replace (21) four and six foot wide fume hoods, complete with fume hood face velocity controllers	$400,200
					Total Estimated Cost - Mechanical Systems	**$1,467,600**

Building 241 Evaluation (continued)

Architecture						
	As-Built Capacity	**Adequate Capacity**	**Condition/Reliability**	**Modernization/ Code Improvements**	**Recommendations**	**Est. Cost**
Major Components						
Facilities	Adequate	No		Restroom facilities are not accessible UFAS Sections 4.15 - 4.23 & 4.3	Install accessible restroom facilities & signage according to code	$154,935
Insulate walls & install new windows				Walls & windows do no meet energy efficiency standards	Insulate walls & install dual pane windows to meet energy standards	$297,755
Construct building entrance foyer				Facility is an office/lab. Need to improve entrance to building	Construct new entrance	$76,155
Access Route to Building				Require acccessible route to facility per UFAS Section 4.3	Construct accessible route from parking to building	$11,590
					Total Estimated Cost-Architecture	**$540,435**
New Laboratory Spaces				Convert High-bay to 6 new Labs	PROGRAM REQUEST	$744,755
Reconfigure Office Space				Reconfigure offices to reduce square footage	PROGRAM REQUEST	$194,615
Floor Trenches				Floor has open trenches	PROGRAM REQUEST	$190,490
Exterior Improvements				Remove old sheds & abandoned equipment	PROGRAM REQUEST	$49,305
					Total Estimated Cost-PROGRAM REQUEST	**$1,179,165**

Building 241 Evaluation (continued)

Alarm Systems							
	Number of Devices	EVA/EP	Number of Speakers	Condition/Reliability	Code/Tech Improvements	Recommendations	Est. Cost
Fire System Type							
System 3	51	EP	88	EP is 40 year old technology. System 3 fire alarm systems is 30 year old technology	EP are not UL listed and are not recognized by a listing agency. System 3 alarms cover a zone that reports to a panel as a single alarm. Firemen must go to panel, find the zone and search area for fire.	Install MXLV alarm and paging system	**$83,400**
Communications Networks							
					Provide a communications outlet in each office. Each station to consist of 3 Cat5e (I for voice, 2 for data) and 4 laser enhanced fiber optic connections.		**$284,020**

Building 253 Evaluation

Low Voltage Electrical Distribution Systems (EDS)

	As-Built Capacity Nameplate	(AMPS) Operating	Adequate Capacity	% Avg. Operating Load	% Peak Operating Load	Condition/ Reliability	Modernization/ Code Improvements	Recommendations	Est. Cost
Major Components									
Main Breakers	1,200	960	Yes	47	59	Old style thermal type	Main breaker is old style thermal type and does not include multiple trip settings	Replace with multiple trip setting adjustable breaker.	3000; Maintenance Operating Funds
Distribution Panels						Multiple panels are 40+ years old & have exceeded their design life and are in fair condition. In CAS backlog.	Breakers are not coordinated properly between panels 720A & 720A6 & panels 723A & 723A40. Panels 724A, 721A & 722A do not have secondary protection. Panel 720A has short delay;ground fault protected.	1. Perform load & breaker coordination studies.	5000; Maintenance Operating Funds
							720A6 & panels 723A & 723A40. Panels 724A, 721A & 722A do not have secondary protection. Panel 720A has short delay; ground fault protected.	2. Install circuit breaker enclosures to provide secondary protection for three panels.	$49,435
Transformers						Multiple transformers are 40 plus years old, have exceeded design life and are in fair condition. In CAS backlog.	Transformer feeding PNL 582B is multi-tapped and has potential to be overloaded.	Install new 30 Kva 480/208-120V transformer, 40 amp 480V, 3P breaker & 100 amp 240V circuit breaker enclosure	$18,315
Feeder Cables			No			40 to 45 years old, poor condition.	Eighteen feeder cable runs between panels have old syle RHW insulation. Three neutral/ground wires connected between panels are undersized	Replace old RHW insulated cables with THHN cable & install properly sized neutral/ground cables	$206,050
								Total Estimated Cost - Electrical Systems	**$281,800**
Emergency Generators	175kw		Yes			22 years old, satisfactory condition. Not in CAS as a deficiency. Permit Source #1335.	Generators older than 1990 will most likely not meet EPA emission regulations.	Generator scheduled for replacement in FY2008	**$124,000**

Building 253 Evaluation (continued)

Mechanical Systems							
	As-Built Capacity		Adequate Capacity	Condition/Reliability	Modernization/ Code Improvements	Recommendations	Est. Cost
Major Components							
Cooling							
Chillers - West Wing - 20 Ton Middle Wing - 125Ton East Wing - 40 Ton	185 Tons		No	Chillers were recently replaced but are supplemented by many small AC units.	Middle wing has many small AC units to supplement the central HVAC system East Wing also has many small AC units which serve Rooms 1916 & 1918.	Install a new 15, 000 CFM outside air rooftop AC unit package & replace existing numerous small AC units. Use either ACU05 or ACU06 to serve office area & other Laboratory if duct work is replaced at Middle Wing. Install a new 5,000 CFM rooftop package in East Wing for computer room.	$626,200
					Existing ductwork has broken down internal insulation at West Wing.	Remove existing ductwork in middle wing & replace with new ductwork. West Wing ductwork completed.	$1,320,500
					Operational & Energy efficiencies can be achieved by installing a VAV system with hot water reheat (Middle Wing)	Convert office area in middle wing to (VAV) system. Install inlet valves in S/A & R/A fans of air handlers.	$572,800
					Boilers & chillers are co-located in the same mechanical room of each wing & there are no refrigerant leak detection systems in any of the mechanical rooms. Both do not meet current building code. Chiller/boiler system needs to be separated & consolidated.	Replace RCHS01-B2 chiller with a 200 Ton unit to serve entire building.	$504,400
					Controls are pneumatic, obsolete and costly to maintain.	Replace pneumatic controls with DDC system for entire bulding to manage flows, temperatures & operations of HVAC.	$446,700
Air Handlers - Approximatley 18 units of various sizes			Yes	Major units for East & West wings were replaced in 1997. One unit in Middle Wing is scheduled for FY04 & the other in the near future.	See Note # 3 above for Air Handlers		
Boilers –							
BHW-01A -West Wing BHWOZB - Middle Wing BHN03C- East Wing	600 MBH 1339 395			BHW03-C replaced in 1997	Boilers & chillers are co-located. Code requires separate chiller & boiler rooms	Replace BHW01-A boiler & install a new 3,000 MBH boiler pump, variable frequency device & expansion tank for entire building	$395,400

Building 253 Evaluation (continued)

Mechanical Systems (continued)							
Plumbing			Yes				
Fire Sprinklers			Yes	Good			
Mechanical Utilities			Yes	Good			
Sewer			Yes	Good			
Fume Hoods/Exhaust System			Yes		Fume hoods have separate exhaust systems with short stacks	Install a centralized 20,000 CFM fume hood exhaust system on roof to manifold all fume hood ductwork with single exhaust stack. Provide two exhaust fans.	$693,300
						Total Estimated Cost - Mechanical Systems	**$4,559,300**

Building 253 Evaluation (continued)

Architecture							
	As-Built Capacity		Adequate Capacity	Condition/Reliability	Modernization/ Code Improvements	Recommendations	Est. Cost
Major Components							
Restrooms					Restroom facilities are not handicap accessible	Remodel restrooms to provide handicap access	$73,700
Door Hardware					Door locksets do not meet UBC and Fire Code	Replace door hardware	$34,800
Ramp					Ramp at East end of central corridor is not handicap accessible	Replace ramp	$31,030
Insulate Exterior Concrete Walls					Office walls are not insulated to current energy standards	Install rigid insulation to provide RI9 rating. Install dual pane windows	$728,170
						Total Estimated Cost - Architecture	**$867,700**

Alarm Systems							
	Number of Devices	EVA/EP	Number of Speakers	Condition/Reliability	Code/Tech Improvements	Recommendations	Est. Cost
Fire System Type							
MXL- R	19	EP	54	EP uses 40 year old technology	EP not UL listed or recognized by a listing agency. EP systems are not supervised. If speaker wires are cut or the amp or speakers fail, no trouble call is sent to dispatch.	Install MXL-V alarm/page system	**$29,700**
Communications Network							
					Provide a communications outlet in each office. Each station to consist of 3 Cat5e (1 for voice, 2 for data) and 4 laser enhanced fiber optic connections.		**$424,615**

Building 271 Evaluation

Low Voltage Electrical Distribution Systems (EDS)									
	As-Built Capacity Nameplate	(AMPS) Operating	Adequate Capacity	% Avg. Operating Load	% Peak Operating Load	Condition/ Reliability	Modernization/ Code Improvements	Recommendations	Est. Cost
Major Components									
Main Breaker(s)	800	640	Adequate	72	74	Fair - 30 yrs old	Main breaker load is close to desired operating capacity. Has min/max settings. Ground fault protected.	Install multiple trip setting breaker (1000 amp) & 2000 amp enclosure.	$8,500
Distribution Panels	—	—	No	—	—	Fair - 5 panels & 2 MCC's have exceeded design life. In CAS	Three panels have miscoordinated breakers	Perform load & breaker coordination study	$5,000
Transformers	—	—	No	—	—	Fair - Six transformers listed in CAS have exceeded design life	Transformer 0278TBE has potential of being overloaded	Replace 30Kva transformer. Install new 75 Kva transformer, two 100 amp CB enclosures, conduit, cable and breakers rated at 70 & 100 amps. Reroute conduit. Replace breakers in panel E279A	$38,773
Feeder Cables	—	—	No	—	—	Fair	Five ground cables are undersized	Remove THW cable & install THHN ground cables	Included in transformer estimate
								Total Estimated Cost - Electrical Systems	**$52,273**
Emergency Generator(s) 271 GDE 01 271 GDE 02	175kw 175	263 263	Yes Yes	—	—	22 years old Permit Source #1339 18 years old	Generator—271 GDE 01 most likely will not conform to EPA regulations for emissions	Scheduled for replacement in FY2008	**$124,000**

Building 271 Evaluation (continued)

Mechanical Systems							
	As-Built Capacity		Adequate Capacity	Condition/Reliability	Modernization/Code Improvements	Recommendations	Est. Cost
Major Components							
Cooling							
Chillers - South Portion/Ground floor, Basement & Radio Room	One 40-ton & one 3/4-ton split heat pump system		Yes	Chiller being replaced in kind	Chiller & boiler are co-located in same mechanical room. No refrigerant leak detection system installed. Controls are partially DDC&pneumatic	1.Install a new refrigerant detection/ventilation system in mechanical room where boiler & chiller are co-located. Provide interlock to shut down boiler.	$42,800
North Portion of Ground Floor	Three Rooftop packaged units, direct-expansion cooling & gas heating. 15.5 tons cooling/165 MBH heating		Yes	Good	Rooftop units are constant volume, energy inefficient & costly to maintain single units	2. Convert constant-volume mixing boxes to double-duct VAV boxes & install inlet vanes at supply fan of ACU-01-A1 & return fan FR-01-A1. Instlal new VAV box & ductwork to serve radio room. Remove existing 3/4 ton heat pump	$433,900
						3. Replace pneumatic controls with DDC system for entire building.	$150,000
Northern Portion Basement (Computer Room)	Two 20-ton 12,000 CFM units		Yes	Recently replaced	Consolidate rooftop package units	4. Replace rooftop units with a 6,000 CFM VAV rooftop air handling unit & VAV with reheat.	$230,600
						5. Replace existing 40-Ton chiller in South portion with a new 60-ton chiller, chilled water pump, variable frequency drive for pump, expansion tank & connection for mobile chiller. Route chilled water supply & returns to new rooftop unit.	$459,600
Heating - One Boiler	400 MBH		Yes	Fair - exceeded design life; 31 yrs. Old	Centralize heating system & provide critical redundancy	Replace existing boiler with two new 200 MBH boilers to serve entire building except computer room	$305,500
Plumbing	Satisfactory		Yes	Good	None	None	
Fire Sprinklers	Satisfactory		Yes	Good	None	None	
Mechanical Utilities	Satisfactory		Yes	Good	None	None	
Sewer	Satisfactory		Yes	Good	—	None	
						Total Estimated Cost - Mechanical Systems	**$1,622,400**

Building 271 Evaluation (continued)

Architecture

	As-Built Capacity		Adequate Capacity	Condition/Reliability	Modernization/ Code Improvements	Recommendations	Est. Cost
Major Components							
Restrooms	Adequate		Adequate		Route to women's restroom is not accessible.	Remove wall & reconfigure restroom	
Door Locksets					Door hardware does not meet UF AS Section 4.13.9	Replace door hardware	
Stairs and guardrails					Stairs, handrails & guardrails do not meet UBC & NFPA code	Replace stairs, guardrails & handrails	
Door Strike Clearance					Some doors do not meet UBC & UFAS requirements	Reconfigure wall/door relationship	
						Total Estimated Cost - Architecture	**$140,000**

Alarm Systems

	Number of Devices	EVA/EP	Number of Speakers	Condition/Reliability	Code/Tech Improvements	Recommendations	Est. Cost
Fire System Type							
System 3	35	EVA	65	Fire alarms use conventional zone technology. EVA systems no longer vendor supported. Some parts are still available UL listed & NFPA compliant	Combine fire & paging systems into single system (MXLV)	Replace fire & paging systems with MXLV system	**$60,000**
Communication Networks							
					Provide a communications outlet in each office. Each station to consist of 3Cat5e (1 for voice, 2 for data) and 4 laser enhanced fiber optic connections.		**$240,910**

Building 361 Evaluation

Low Voltage Electrical Distribution Systems (EDS)									
	As-Built Capacity Nameplate	(AMPS) Operating	Adequate Capacity	% Avg. Operating Load	% Peak Operating Loan	Condition/Reliability	Modernization/ Code Improvements	Recommendations	Est. Cost
Major Components									
Main Breaker - 220A	2,000	1,600	Yes	67	69	Old	Main breaker does not have multiple trip settings	Install multiple trip setting, main breaker. Perform load & breaker coordination study	$15,400
Main Breaker - 1829A	1,600	1,280	Yes	22	23	Recent replacement	Main breaker has multiple trip settings		
Distribution Panels						Fifty panels are 36 years old & have exceeded design life. Listed in CAS as Fair	No secondary protection exists between two panels	Install secondary line protection between PNLE 220A-6-3A & PNL 225A & E225B. Update enclosure to NEC code. Requires 36-inch spacing to meet current code.	Included in cable estimate
Transformers						Nine transformers are 36 years old & have exceeded design life. Listed in CAS as Fair		CAS replacements	Maintenance Operating Funds
Feeders, Cables						Identified eight cable runs with old style RHW insulation.	Four cable runs have undersized neutral/ground conductors	Replace RHW cables & update neutral/ground conductors to code.	$176,300
								Total Estimated Cost- Electrical Systems	**$196,700**
Generators - 361GDE-01	400	601	Yes			Satisfactory for present - Permit source # 1359	Generators may not conform to EPA emission requirements in FY2006	Generator 361GDE01 scheduled for replacement in FY2007	**$154,000**

Building 361 Evaluation (continued)

Mechanical Systems						
	As-Built Capacity	**Adequate Capacity**	**Condition/Reliability**	**Modernization/ Code Improvements**	**Recommendations**	**Est. Cost**
Major Components						
Cooling						
Chillers - Two screw machines: 1-200 tons & the other 250 tons serving Increment I and Increment II of B361	450 Tons	Yes	New, recently replaced	Chillers are co-located with boilers which do not meet current building code for machine rooms.	Install an interlock for fuel burning equipment to shutdown boilers in the event of a refrigerant leak.	$206,800
				A chilled water loop between B361 & B364 would provide redundancy for both facilities.	Replace old 60-Ton chiller & pump in B364 & interconnect B361 with a chilled water loop to provide redundancy for both facilities. 2a. Install DDC system to communicate HVAC system status to M/O	$79,200
				Controls in Increment I are non-operative & obsolete. Increment II controls are pneumatic.	Replace obsolete controls with Direct Digital controls to manage room air supply temperatures, damper control, etc. Install a front-end computer with graphics to communicate with local unit controllers	$188,600
				Rooms converted to computer server nodes require additional cooling.	Install self-contained AC units in server rooms.	$74,300
Air Handlers - Increment I (5 units) Increment II (3 units)	75,000 cfm ~19,000 cfm	Yes	New, recently replaced	System is constant volume reheat air at 55 degrees F & is heated to room temperature by room thermostats	Modify existing air handlers by installing VAV boxes with heating coils in office areas. Install new DDC & variable frequency drives.	$1,572,600
Boilers - Two 2,000,000 BTU/H	2,000,000 BTU/H per boiler	Yes - peaks at 85% at highest demand	Boilers replaced in FY03/04	Pumping capacity is deficient. Old pumps were not replaced during boiler replacement. Control modifications would increase efficiency & operation of boilers	Install new hot water boiler pumps with higher pumping head capacity. Install DDC controls to communicate boiler status via LON talk to a central location at maintenance/operations	$71,300 $77,800
Plumbing	Satisfactory	Yes		Meets current code. Two hot water tanks and heat exchangers have exceeded design life	Replace with smaller tanks & instantaneous type hot water generators. Approximate tank size 200 gallons each.	$129,600
Steam Plant	Satisfactory	Yes, excess capacity	Installed 2003	Meets current code. Installation of DDC controls could improve monitoring & efficiency of plant.	Install DDC controls to communicate information & status via LON talk to a central location at Maintenance/Operations	$77,800

Building 361 Evaluation (continued)

Mechanical Systems (continued)						
Fire Sprinklers	Satisfactory	Yes	Satisfactory	Meet Code	None	
Mechanical Utilities	Satisfactory	Yes	Satisfactory	Meet Code	None	
Fume Hoods	Satisfactory	Yes	Old	Two dozen fume hoods are connected to individual fans located on the roof stacks, terminate just above the roof.	Replace existing fume hoods & include local hood alarms & monitors for room pressures. Maintain constant volume air characteristics for laboratories.	$1,131,700
Hood Exhaust Fans	Satisfactory	Yes	Old		Install a centralized exhaust system & manifold hoods to a common ductwork system. New system to consist of two fans: one redundant for 100% backup. Install a single new stack which will help hood exhaust from re-entering outside air intakes.	$583,400
Exhaust Fans & HEPA Filter System Increment II				A central exhaust system serves some fume hoods that exhaust through one set of HEPA filters & carbon absorbers. The HEPA filter does not meet current requirements for a testable system.	Remove & replace existing fans and HEPA filter system with more modern and efficient system, including DDC controls	$426,000
					Total Estimated Cost - Mechanical Systems	**$4,619,100**

Building 361 Evaluation (continued)

Architecture

	As-Built Capacity	Adequate Capacity	Condition/Reliability	Modernization/ Code Improvements	Recommendations	Est. Cost
Major Components						
Restrooms				Restrooms near auditorium do not meet handicap accessiblity	Remodel existing restrooms & install signage	
Door Hardware				Door hardware does not meet UFA requirements	Replace door hardware	
Guardrails				Existing guardrail at basement access stairwell is not UBC compliant	Install new guardrail	
					Total Estimated Cost - Architecture	**$261,400**

Alarm Systems

	Number of Devices	Number of Speakers	Condition/Reliability	Code/Tech Improvements	Recommendations	Est. Cost
Fire System Type						
System 3	66	100	EP is 40 year old technology and is not UL listed	Fire alarm system is 30 year old technology. UL listed & NFPA compliant. Employs conventional zone technology. All devices report to panel as a single alarm. EP not UL listed.	Replace fire and evacuation page system with MXL-V system	**$99,600**
Communications Network						
						$567,015

Building 381 Evaluation

Low Voltage Electrical Distribution Systems (EDS)									
	As-Built Capacity Nameplate	(AMPS) Operating	Adequate Capacity	% Avg. Operating Load	% Peak Operating Load	Condition/Reliability	Modernization/Code Improvements	Recommendations	Est. Cost
Major Components									
Main Breaker (s)									
340A	2,500	2,000	Yes	29	33		Main Breakers do not have multiple trip settings - only min/max settings	Install new main breakers with multiple trip settings. Perform load & breaker coordination studies.	$51,100
341A	2,500	2,000	Yes	22	28				
342A	800	640	Yes	12	13				
343A	3,000	2,400	Yes	21	23				
Distribution Panels						Fair condition. Many of the panels have exceeded design life or are slightly deteriorated and are in the projected backlog.		Maintenance backlog reduction items	Maintenance Operating Funding
Transformers						Transformers are 30 years old, have light deteriorization and are in the projected backlog.		Maintenance backlog reduction items	Maintenance Operating Funding
Feeders, Cables							Panel schedules have incomplete entries. Feeder sizes, type, conduit & breaker sizes are missing from schedules	Replace old RHW feeders with THWN feeders. Replace undersized feeders. Update panel schedules	$678,400
								Total Estimated Cost - Electrical Systems	**$729,500**
Generator	150KW		Yes			28 years old. Permit Source # 1362	Generator most likely will not conform to EPA regulations	Scheduled for replacement in FY2007.	**$60,000**

Building 381 Evaluation (continued)

Mechanical Systems	As-Built Capacity		Adequate Capacity	Condition/Reliability	Modernization/ Code Improvements	Recommendations	Est. Cost
Major Components							
Cooling							
Chillers - Two, 275-ton centrifugal units	550 Tons		Yes - Matched to air handling capacity	New, recently replaced and have another 20 years service life.	Refrigerant exhaust & monitoring systems meet current code. Chillers not equipped with direct digital controls. Operational & energy efficiencies can be achieved by installing direct digital controls.	Install DDC controls on chillers interfaced with a central computer monitored by Maintenance/Operations	$129,700
Air Handlers - Lab Section - - - - - - - - - - ACU5-A1 ACU6-A1 ACU7-A1 ACU11	Cooling MBTU/H 1464 1290 1480 420	Heating MBTU/H 810	Cooling CFM 100,000 43,200 25,000 8,000		1. Existing air handling system and mixing boxes in office area are inefficient. Constant volume. Installation of new dual duct VAV boxes and controls would improve energy & operational efficiency of air handling system. 2. Re-heat coils in lab portion are energy inefficient. 3. HVAC system has no central control & monitoring system	1. Modify air handling system by installing dual duct VAV boxes, complete with integral controls for office area. 2. Install new DDC thermostats and control valves on reheat coils serving laboratories. Interface with newly installed central controls to reset supply air temperature and minimize wasteful reheating of main supply air. 3. Install front-end computer to interface with local controllers and thermostats to manage room & air supplly temperatures, fan RPM, damper control, etc.	(1) $2,758,400 (2) $224,300 (3) $129,700
Office Area - - - - - - - - - ACU1-A1 ACU2-A1 ACU3-A1 ACU4-A1	Cooling MBTU/H 540 560 638 630	Heating MBTU/H 450 530 530 530	Cooling CFM 16,000 16,500 19,820 19,000				
Boilers - Two 100 HP			No	Fair Condition - Boilers are 31 years old and have exceeded design life.	1. Original boiler capacity was adequate. Heating capacity is inadequate since B481 was connected to boilers. Cannot meet demand on cold days. 2. Operational and maintenance efficiencies can be achieved by installing a front-end computer to monitor boilers	1.Install two, 150 HP boilers to carry demand for both buildings. 2. Install DDC to monitor boilers. Install DDC controls on boilers to monitor & communicate status to central computer in M/O	(1) $671,900 (2) $96,000
Plumbing			Yes	Good			
Fire Sprinklers			Yes	Good			
Mechanical Utilities			Yes	Good			
						Total Estimated Cost - Mechanical Systems	**$4,047,000**

Building 381 Evaluation (continued)

Architecture							
	As-Built Capacity		Adequate Capacity	Condition/Reliability	Modernization/ Code Improvements	Recommendations	Est. Cost
Major Components							
Restrooms					Restrooms (1201A, 1201C) are not handicap accessible. Code UFAS Section 4.15-r.23)	Provide handicap accessible restrooms	
Door Hardware					Door hardware not to current code	Replace door hardware	
Stair Treads & Stair Handrails					Existing stair treads, risers and handrails do not meet current code	Replace stair treads, risers & handrails.	
Auditorium					Stage not handicap accessible	Provide handicap access to stage and lighting	
						Total Estimated Cost - Architecture	**$215,800**

Alarm Systems							
	Number of Devices	EVA/EP	Number of Speakers	Condition/Reliability	Code/Tech Improvements	Recommendations	Est. Cost
Fire System Type							
MXL-R	61	EP	190	EP is 40 year old technology	EP systems are not UL listed. MXLV is a fire alarm and voice evacuation system in one	Reconfigure to MXL-V system	**$104,500**
Communications Network							
					Provide a communications outlet in each office. Each station to consist of 3 Cat 5e (1 for voice, 2 for data), and 4 laser enhanced fiber optic connections.		**$211,835**

Building 851A Evaluation

Low Voltage Electrical Distribution Systems (EDS)									
	As-Built Capacity Nameplate	(AMPS) Operating	Adequate Capacity	% Avg. Operating Load	% Peak Operating Loan	Condition/ Reliability	Modernization/Code Improvements	Recommendations	Est. Cost
Major Components									
Main Breaker	800	640	Yes				Existing main breaker is old style	Replace main breaker with multiple trip setting unit	$3,200
Distribution Panels								FY04 FIRP addressed low voltage electrical maintenance & repair, replacing panels, transformers and some feeders	
Transformers									
Feeder Cables						Old conduit is deteriorated. Reliability is marginal	Portions of existing electrical conductors were identified with old style insulation (RHW). Two electrical panels have undersized neutral/ground cables.	Replace undersized neutral & cables & RHW cables. Some cables were replaced in FY04.	$77,643
Emergency Generators			Yes			14 years old	Generator most likely will not conform to EPA regulations	Generator study is in progress	

Building 851A Evaluation (continued)

Mechanical Systems							
	As-Built Capacity		Adequate Capacity	Condition/Reliability	Modernization/Code Improvements	Recommendations	Est. Cost
Major Components							
Cooling							
Chillers -	1- 60 Ton scroll compressor, water cooled		Yes	Recently installed - 1996	Cooling tower is constructed of galvanized steel and is badly corroded	Replace cooling tower with stainless steel or plastic to reduce corrosion	–
Air Handlers -	3 units = 75 tons cooling capacity & 24,200 cfm		Yes		Pneumatic controls are used for all HVAC equipment	Replace with Direct Digital Controls with connection to A/C shop. Modify existing multi-zone HVAC system (ACU-1) to a variable volume (VAV) system. Provide ACU-1 fan with a variable frequency drive, close off heating deck and add 7 VAV terminal units with electric reheat	–
Boilers	Heating is provided by electric coils		Yes		None		
Plumbing			Yes				
Fire Sprinklers			Yes				
Mechanical Utilities				Not Available to Site 300			

Building 851A Evaluation (continued)

Architecture							
	As-Built Capacity		Adequate Capacity	Condition/Reliability	Modernization/Code Improvements	Recommendations	Est. Cost
Major Components							
Restrooms Remodel	Inadequate			Poor	Restrooms are not acessible UFAS Section 4.15 - 4.23. Facilities are inadequate. No provision for women	Remodel restrooms and provide facilities for women. Design is complete	$147,565
Canopy						Install canopy to provide entry & shelter for occupants	$19,535
						Total Estimated Cost - Architecture	**$167,100**

Alarm Systems							
	Number of Devices	EVA/EP	Number of Speakers	Condition/Reliability	Modernization/Code Improvements	Recommendations	Est. Cost
Fire System Type							
MXL		None		Good	Emergency paging similar to Livermore Site does not exist	Upgrade to MXL V	—
Communications							
				No communications network at Site 300			